

TENDER NO. IPR/TN/PUR/TPT/ET/19-20/10 DATED 24/06/2019

Specification

For

Supply, Detailed Engineering, Erection, loading & unloading, Integration with 11kV Bus, pre-commissioning and Integrated Commissioning of the 11kV, 1600KVAR, Automated Power Factor Correction (APFC) System for 132 kV/11kV substation with all the necessary equipment.

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I - Project Information & Auxiliary Facilities

1.	Purchaser	Institute for Plasma Research Village Bhat, Gandhinagar Dt. PIN-382 428 Gujarat, INDIA Phone: +91-79-23962000 Fax: +91-79-23969017 Web: www.ipr.res.in
2.	Delivery and Installation Address	Institute for Plasma Research Village Bhat, Gandhinagar PIN-382 428 Gujarat, INDIA Phone: +91-79-23962000 Fax: +91-79-23969017 Web: www.ipr.res.in
3.	Site elevation (average)	55 meters above MSL
4.	Ambient temperature	Max. (annual): 47 °C ; Min. (annual): 4 °C Average (annual): 35 °C Design (max): 50 °C; (min): 4 °C
5.	Relative humidity	Max.: 95 % ; Min.: 10 %
6.	Rainfall	823 mm average (annual) June-August
7.	Wind data	Max. wind speed: 130 kmph Prevailing direction: SW to W Design wind pressure: 150 kgm-2
8.	Seismic data	0.08 g (as per latest guidelines)
9.	Accessibility	by road : up to site (Hansol-Gandhinagar H-way) by rail : Ahmedabad Rly. Stn. (12 km.) by sea : Bombay Harbor (525 km.) by air : Ahmedabad Airport (6 km.)
10.	Auxiliary power supply (each of the voltages can be made available at one point of connec- tion to the sources)	a) AC 415 V \pm 10 % V, 3 phase, 50 \pm 5% Hz, 4 wire system b) DC 220 V \pm 20 % V, 2 wire, floating
11.	Expected date of commissioning	3 months or earlier from the date of LOI

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II – TECHNICAL SPECIFICATIONS

1. SCOPE OF SUPPLY

The scope includes detailed engineering, factory-inspection, supply, unloading, handling at site, erection, integration, site testing, pre-commissioning, integrated commissioning of the 11kV, 1600KVAR Automated Power Factor Correction (APFC) System for 132 kV/11kV substation with all the necessary equipment.

The scope of work includes:

Phase.1: After receiving the purchase order:

Detailed engineering of APFC system, preparation of documents (general arrangement, component selection, design criterion/calculations etc.) and quality assurance plan, for approval,

Phase.2: After receiving approval:

Necessary procurements, APFC system assembly, performance of factory acceptance test (FAT), preparation of test reports and submission to purchaser for dispatch clearance,

Phase.3: After receiving Dispatch Clearance:

Delivery of APFC system after obtaining dispatch clearance from purchaser, erection, integration, performance of site acceptance test, pre-commissioning, integrated commissioning of the 11kV, 1600KVAR Automated Power Factor Correction(APFC) System for 132 kV/11kV substation with all the necessary equipment, preparation of commissioning report, obtain final acceptance.

Phase.4: After commissioning and final acceptance:

Compliance as per warranty clause.

The offered material shall be complete with all components necessary for their effective and trouble free operation. Such components shall be deemed to be within the scope of Bidder's supply irrespective of whether those are specifically brought out in this specification and /or in the commercial order or not.

2. CODES, STANDARDS & STATUTORY NORMS

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The design, materials, construction, manufacture, inspection, testing, performance, installation, integration and commissioning of all equipment & materials shall comply with all currently applicable statutes, regulations and safety codes in the locality where the equipment will be installed. Unless specified otherwise in this specification, all components shall comply with the latest versions of IS/IEC. Some of the reference standards are mentioned as follows:

IS/IEC No.	Title
IS 13925 : 1998 or IEC 60871	Specification for H.T. Shunt Capacitor
IS 9920-2002 or IEC:62271-106	Vacuum Contactors/Capacitor Switch
IS 9921-1985	Isolator
IS 2705	Current Transformer
IS 3156	Residual Voltage Transformer (R.V.T)
IS 5553	Series Reactor

2.1 CUSTOMER INPUT DATA

Sr. No.	Description	Input Data
1.	Application of the 11kV, 1600KVAR HT APFC System	To improve the power factor of the system to unity and mitigate the existing harmonics.
2.	Control Supply	
i.	AC Input	
	Input Voltage	415V
	I/P voltage variation	±10%
	Phase	3 phase, 4 wire
	Frequency	50Hz
	Frequency variation	±3%
ii.	DC Input	
	Voltage	220V DC

3. DETAILS OF APFC SCHEME:

- 3.1 All controls, switching devices, and protection features are enclosed in a sheet steel enclosure. The banks shall come fully suitable for Indoor installation on structure along with all the necessary equipment.
- 3.2 The APFC shall be indoor, floor-mounted, self-supporting sheet metal enclosed cubicle type. The bidder shall supply all necessary base frames, anchor bolts and hardware. The

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Panel shall be fabricated from minimum 2.0 mm cold rolled sheet steel. Removable gland plates for all cables and lugs for power cables shall be supplied by the bidders. The lugs for power cables shall be made of electrolytic copper with tin coat. Power cable sizes shall be advised to the contractor at a later date for provision for suitable lugs and drilling of gland plates. The APFC panel shall be tropicalized and vermin proof. Ventilation louvers, if provided shall be backed with screens. All doors and coves shall be fitted with synthetic rubber gaskets. The APFC panel shall have hinged double leaf doors provided on front and on backside for adequate access to the APFC's internals. The APFC panel cubicle doors shall be properly earthed. The degree of protection of APFC panel shall be at least IP-42 as per IS 13947 part I.

The APFC panel comprises Capacitor banks in steps, 6 % Series Reactors, cold rolled cold annealed (CRCA) Cubicle, Vacuum switches/contactors, HT Fuses, Isolator, Power & Control cables (supplied by IPR).

3.3 APFC Panel:

The APFC panel shall comprise of following sub-sections of Incomer + 4 Outgoing feeders. Control Unit shall be part of APFC panel. 11kV, HT panel with IP42 protection Class, suitable for indoor free standing floor mounted type installation designed to Switch HT Capacitor banks.

Part-1: Incomer panel.

Control Cubicle:

It shall continuously monitor the total kVAr requirement and automatically switch ON/OFF the individual capacitor banks. Panel shall be free standing floor mounted with minimum IP42 protection class. It consists of minimum following equipment for the smooth operation of Auto switched capacitor banks.

- Microprocessor based Automatic Power Factor Controller as per the detailed technical specification.
- ON/OFF indications for each step vacuum contactors and Isolator.
- Delay timer shall be provided to maintain a minimum interval of 10 minutes between the operations of each capacitor bank.
- Multifunction meter with Modbus communication protocol
- Numerical relay with O/c, E/f, O/v, U/v, protections with Modbus RS-485 protocol for complete bank

Power Cubicle:

- 9 kV, 10 kA, Gapless, Single Pole Metal Oxide Class – III indoor FRP type Surge Arrestors conforming to IS 3070 or IEC 99-4/1991. The lightning Arrestors shall be of metal oxide, heavy duty type and should have impulse flash over characteristics.
- 11 kV, 400A, 3-Ph, 50Hz, 25kA/1sec, indoor type, panel mounted, manually operated Off-load type isolator with earth switch.
- 3 nos. of 1-Ph, Potential transformer: 11kV/110V, 50VA, Class 0.5, indoor resin cast panel mounted

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- 3 nos. of 1-Ph Current transformer: 11kV of suitable current rating, indoor resin cast panel mounted
- Set of Aluminium bus bars of suitable size and rating and set of earth bus bars. Panel Incoming shall be suitable for 11 kV XLPE Cable provided at the Incoming Cubicle. Cable entry shall be suitable for Top entry.

Part-2: Outgoing steps

Each outgoing step shall comprise of the following equipment. The equipment shall be of Indoor type mounted inside the metal enclosed panel.

- 3 nos. of 12 kV, HRC fuses suitably rated considering capacitor bank rating.
- 3-Phase 12 kV, 400 Amps, indoor Vacuum contactors suitable for any control voltage as per the enclosed technical specification.
- 1-Phase, 11 kV, 6% Iron Core, Dry type Series Reactor suitable for Inrush Current limiting and harmonic detuning.
- 3-Phase, 3 bushing, Capacitor units as per technical specification.

Enclosure Details

- Indoor type, floor mounted, CRCA cubicle with epoxy based powder coated paint
- Indoor with minimum IP42 protection
- Base frame of minimum 75mm Indian Standard Medium Channel (ISMC) (black)
- Enclosure shall be with 2.0mm for load bearing members and 1.6mm for non-loading members.
- Front hinged doors, side and rear bolted type fixed door (no direct rear access).
- Doors shall have lockable swing handle (3 point lock assembly)
- Method of cable entry is Top.
- 3mm CRCA gland plate for power cable and control cable without punched holes.
- Suitable size Copper earth bus bar running through entire panel. Earth bus bar should be extended at both side for external grid connection
- Main bus bars & HRC fuses shall be designed for 25kA/1sec
- Illumination lamp for each feeder
- Space heaters if required
- Paint shade shall be RAL-7032 - Siemens grey

4.0 ENGINEERING & DRAWING

The successful bidder shall submit all the required design calculations for 11kV 1600 KVAR APFC system and develop his own General Arrangement (GA) and Schematic Drawings, adding necessary auxiliary devices, accessories, component particulars of the supplied equipment, etc., which are required for a safe, convenient, efficient and proper operation of the APFC system and shall submit for the Purchaser's review and approval.

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The Purchaser's approval of the said drawings is an essential requirement before proceeding with any manufacturing activity. The Purchaser's review of the Bidder's drawings shall not relieve the manufacturer of his responsibility for supplying equipment conforming with the relevant specifications and standards or for any mistakes, errors or omissions in the Bidder's drawings.

The Bidder shall submit the prints of all the drawings and documents as well as soft copy indicated in the "Drawing and Documentation Submission", placed in the technical specification.

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5.0 TECHNICAL SPECIFICATION FOR THE MAIN COMPONENTS IN THE APFC SYSTEM

5.1 11KV CAPACITOR BANK

The capacitor banks are used in a 3 phase, 50 Hz 11 KV system. The Capacitor bank shall consists series/parallel combination of small units of capacitor cells per phase, each with an output rating of 300 and 500 KVAR or any other combination. Capacitor units should be connected in externally star with appropriate number of capacitors in parallel as per requirement to achieve p.f. to 1.0. Necessary number of steps should be provided to meet requirement given in the schedule.

Sl. No.	Rated Voltage	Installed voltage	Total MVAR at 11 kV	Step Configuration
1.	11 kV	12.87 kV	1600KVAR	2 x 300kvar + 2 x 500kvar

The capacitor banks shall be complete with series reactor as required, offload type isolators, instrument transformer, and control and relay panels, connecting material and any other material required for capacitor bank may be included in the scope of supply of APFC system. However, tenderer should quote for all the equipment's required for APFC system.

- i. The tenderer shall also furnish details of the connections between the capacitor units and groups, together with layout diagrams showing the physical arrangements of banks, complete with dimensions. Each capacitor unit should be provided with external / internal expulsion fuse 12KV class and suitable current rating.
- ii. Each capacitor unit shall have sheet steel container with suitable mounting bracket which can easily be fixed to frame structures. The container shall be built from heavy gauge CRCA sheet steel of minimum 2.0 mm thick sheet steel with welded seams, mechanically strong, rigid and hermetically sealed. The container of capacitor unit shall be designed to allow for expansion and contraction due to all ambient & loading conditions expected during the life of the unit.
- iii. The capacitor elements shall be thoroughly dried and impregnated with an impregnant that has been completely refined so as not to leave any gas or impurities which may cause deterioration of the dielectric. The impregnant used shall have low viscosity and high chemical stability. It should be non-PCB (NPCB). It shall be incombustible and have a high dielectric constant. Capacitor dielectric shall be 100% polypropylene. However, in case of 100% polypropylene capacitor the polypropylene shall be hazy and aluminium foil should be embossed for proper impregnation. The numbers of layers of dielectric shall be three or more. The details of aluminium foil shall also be furnished. The impregnation shall be carried out under high vacuum & unit shall be

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totally sealed. The raw material to be used for manufacturing of capacitor unit i.e. polypropylene film, non PCB nontoxic oil and aluminium foil shall be of best quality.

- iv. Each unit shall have two bushing for terminal connection. The rating of bushing should not be less than 15 kV, suitable for series / parallel connection with other units to form capacitor bank at 50 Hz. The bushing shall be of porcelain suitable for heavily polluted atmosphere having required creepage distance not less than 375 mm.
- v. The capacitor shall have low value of loss which shall not exceed 0.2 watt per KVAR. The losses in watts for each capacitor unit including losses in fuses and discharge resistors forming integral part of the capacitors along with losses for series reactor shall be guaranteed. If these figures of capacitor losses exceed 0.2W/KVAR, the capacitors will be liable for rejection.
- vi. Total losses shall be complied as below:

6 x (W x n + losses in series reactor)

Where, n is number of capacitor units per phase of star connection and W is the total loss in a capacitor unit. The loss temperature characteristics, capacity temperature characteristics and insulation resistance temperature characteristics shall also be furnished.

The use of **Poly-Chlorinated Biphenyls (P.C.B.)** as dielectric for capacitor shall not be acceptable. The dielectric medium to be used shall be non-poisonous and non-toxic in nature and shall not cause pollution of environment. Each capacitor unit shall be provided with external / internal HT HRC fuse of 12 KV class with suitable current rating.

- vii. **Temperature Category:**
The capacitor shall be suitable for operation with upper limit of ambient temperature 50°C.
- viii. **Rated Voltage:**
The rated voltage of 3 phase capacitor banks shall be 11 KV (phase to phase) and maximum operational voltage shall be rated for 12.87 kV.
- ix. **Rated Output:**
The Rated output of 3 phase capacitor banks shall be 300(02nos.) & 500(02nos.) 1600, KVAR at voltage of 11 KV.
 - a) **Voltage:** The maximum rms voltage that may safely be applied to the capacitor, rated for continuous duty, shall not exceed the rated rms voltage of the capacitor by more than 10%,

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- b) **Current:** The capacitor unit shall be suitable for continuous operating at rms line current not exceeding 30 percent over the current which would flow through capacitors at 11kV+ 10% voltage and 50Hz \pm 3%.
- c) **Discharge:** Each capacitor unit shall contain a directly connected internal discharge resistors, which shall be capable of reducing the residual voltage from crest value of the rated voltage to 50 volts or less within 10 minutes after the capacitor is disconnected from the source of supply. Time of quick switching on & off shall be clearly mentioned.

x. Permissible Overloads:

For capacitor covered in this specification, the maximum permissible overloads with regard to voltage, current and reactive output shall not exceed the limits specified in IS: 13925.

xi. Power Loss:

The power loss in capacitors shall not exceed 0.2 watt / KVAR.

xii. Discharge device:

Suitable discharge device shall be connected across the capacitor unit in accordance with the provision of IS: 13925. The discharge device shall reduce the residual voltage from the crest value of the rated voltage to 50 V or less within 10 **Minutes** after the capacitor is disconnected from the source of the supply.

- xiii. The capacitor units shall be provided with a rating plate and terminal marking as stipulated in IS 2834.

5.2 OPERATION OF CAPACITOR BANK

- a. The capacitors are proposed to be connected in 3 phase, 11 KV, 50 Hz system. It is to be specifically noted that 1600KVAR capacitors bank is intended for use at 132/11 kV sub-station.
- b. Maximum permissible over voltage shall be as per standards and latest amendments thereof.
- c. Permissible increase in current loading due to any or all of the following shall not exceed 30% of the rated current.
 - Increase voltage.
 - Increased frequency
 - Non sinusoidal voltage
- d. The capacitors shall be suitable for operating in temperature category 50° C as per standards.

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5.3 CAPACITOR BANK SWITCHING CONTROL

Switching of capacitor banks would be performed by VC (vacuum contactor) through local/remote mode. Timer must be included with adjustable setting of 0 to 10 minutes to provide a time lag before which the bank shall not be again switched 'ON' (to avoid closing of the circuit breaker on a trapped charge)

5.4 PROTECTION

The capacitor banks shall be provided with the following protections.

- i. Over current and earth fault protection to cover the faults in the capacitor banks and its controlling circuit breaker.
- ii. Over voltage protection.
- iii. No volt protection.

Requirement of each of the above protections are described below:

- **Over current and earth fault protection:** Combination of three over current IDMT relays having 50- 200% settings and one E/F relay of IDMT characteristic with 20-80% setting shall be used with suitable current transformer.
- **Over voltage protection:** Shall be provided with an inverse time characteristic. Over voltage relay shall be energized from a VT connected to the main bus bars on the source side of the circuit breaker controlling the capacitor banks. Setting shall be variable from 100% to 130% in steps at least 1% to 2%.
- **No Volt protection:** No Volt protection should be provided to disconnect the bank under no voltage conditions. This protection shall be energized from the existing bus PT. This protection should not operate in the event of fault on 11 KV lines which may dip the bus bar voltage to 50%. There should be provision for adjustment in setting of voltage and time to coordinate 11 kV lines protection with the no voltage protection to avoid mal operation of No voltage relay under line fault conditions.

5.5 TESTS:

Routine tests

- a) Capacitance measurement.
- b) Measurement of the tangent of the loss angle ($\tan \delta$) of the capacitor.
- c) Voltage test between terminals.
- d) AC voltage test between terminals and container.
- e) Test of internal discharge device.
- f) Sealing test.
- g) Discharge test on internal fuses (If applicable)

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Routine tests shall have been carried out accordance with IS: 13925 by the manufacturer on every capacitor before delivery.

Nominal system voltage	11 kV
KVAR Capacity at nominal system voltage required	1600 kVAr
Design voltage of the Capacitor bank (kV)	12.87 kV
Step Ratings	2 x 500kvar + 2 x 300kvar
Connection of capacitor bank	Internal Star
Power loss	Not to exceed 0.2 Watts/KVAR including losses in fuses subjected to tolerance as per IS 13925
Permissible over loads	Maximum permissible over loads with reference voltage, current and reactive output shall conform to IS 13925.
Type of grounding	Un grounded
Capacitors impregnate	Non-toxic
Type of protection	Internal/External fuse
Type of discharge	Internally through resistor provided within the capacitor units.
Capacity to receive in rush currents	Not more than 10 times rated current.
Temperature	Should be designed for 50°C.

6.0 SERIES REACTORS:

The series reactor of suitable size is required to limit the inrush current due to parallel switching of capacitor banks on the same bus & suppress the harmonic currents. It should be capable of preventing Parallel Resonance in the network due to the addition of capacitors in to the network. The series reactor shall be Indoor type, air cooled, Iron Cored, dry type, copper wound, non-magnetically shielded and would be used for harmonic and inrush suppression. The reactors shall be suitable to carry 130% of the rated current of the capacitor bank.

The voltage rating of the series reactor's base insulator shall be nominal system voltage. Series reactors shall be capable of withstanding the specified short circuit currents. Heat Rise Calculations for the Series reactor should form part of the bid submission. The series reactor would be connected towards neutral of the shunt capacitor. The series reactors shall be complete in all respects including clamps, fixing bolts and nuts and other accessories

6.1 CONSTRUCTION FEATURE:

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6% Series reactor per phase per step of capacitor rating for inrush current restriction to be connected on neutral end as per IS: 5553. The rated voltage shall be 12 KV. The reactor shall be dry type single phase reactors mounted on post insulators and designed to carry 130 % of rated current continuously without exceeding the temperature rise & shall be applicable for thermal class of insulation used. The reactor shall be mounted inside the capacitor cubicle.

6.2 TESTS

The series reactor shall be subjected to following routine test in accordance with IS: 5553.

- a) Temp. Rise at rated continuous current Test
- b) Short circuit Test
- c) Measurement of winding resistance
- d) Measurement of Impedance
- e) Measurement of Load losses
- f) Separate source withstand test
- g) Measurement of IR value

a)	Rated nominal voltage	11KV
b)	Rated capacity / Inductance	6%
c)	Rated frequency	50 Hz
d)	Number of phases	3-phase
e)	Terminal arrangement	Suitable for bus bar/conductor connections on IC & Outgoing side
f)	Maximum system voltage for which reactor is designed	12 kV
g)	Conforming to IEC	IEC 60076-6
h)	Class of Insulation	Class F
i)	Type Of Connection	Line Side Of capacitor
j)	Max operating temperature	90°C (Over Ambient)
k)	Type	3-phase, Iron core

7.0 VACCUUM CONTACTOR:

Operating Characteristics

Sl. No.	Description	Requirement
1.	Rated Voltage (kV)	12
2.	Continuous current (A)	400A
3.	Capacitive switching current (A)	250
4.	Frequency (Hz)	50

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5.	Short time (symmetrical) withstand current	10 kA for 1 sec
6.	Nominal open time (msec)	35...60
	Nominal close time (msec)	60...90

7.1 General Specification:

This specification covers 11 KV, 50 Hz, Indoor type capacitor switches suitable for switching capacitor banks of 300 KVAR, and 500 KVAR ratings. HRC Fuse having minimum Short Time Current (STC) of 10kA rating shall be used in series with vacuum contactor. Vacuum contactor shall be of capacitor duty and suitable for back to back switching of the capacitor banks. The Vacuum contactor should have trip lever for emergency opening operation and mechanical Indicator to check the no. of operations.

7.2 RATED VOTAGE The rated voltage for the capacitor switch shall be 12.87 kV. This represents the highest system voltage corresponding to the nominal system voltage of 11 KV.

7.3 RATED CURRENT

The standard rated normal current shall be 400A.

7.4 RATED CAPACITIVE SWITCHING CURRENT

The rated capacitive switching current shall not be less than 250A.

Note: The capability of the switch shall also take into account the parallel switching of capacitor bank steps.

7.5 RATED SHORT TIME CURRENT

The rated short time symmetrical current for 1 second shall be 10KA (rms A.C.component).

7.6 RATED MAKING CURRENT

The rated making current shall be 2.5 times the rms value of the a.c. component of rated short time capacity.

7.7 BASIC IMPULSE LEVEL (BIL)

The rated basic impulse level of switch to earth as also across the open terminals shall be 75KV.

7.8 CONTROL SUPPLY

The control power for closing the switch shall be 415 V three phase AC/ 220VDC supply. The closing mechanism shall be suitable for a voltage variation of (+) 10% to (-) 10%.

7.9. OPERATING MECHANISM

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The operating mechanism shall be solenoid type.

7.10 MECHANICAL ENDURANCE

The switch shall be capable of performing service life (mechanical closing latching) of 1,00,000 operating cycle.

7.11 VACUUM CONTACTOR TESTS

Routine tests

- Reference standard- IEC 62271/ IEC 62271-106
- Design and visual checks
- Mechanical and electrical operating tests
- Power frequency voltage withstand test
- Voltage drop test
- Contact speed measurement test
- Operating time and rated voltage measurement

8.0 Bus bar General Specification:

The bus bars shall be of E91 electrolytic grade aluminium alloy with uniform section throughout the panels and shall be of suitable current carrying capacity.

- The Bus bar support insulators shall be non-hygrosopic anti-trekking epoxy rated for 12 kV.
- The bus bars shall be insulated with heat shrink sleeves, which shall be track-resistant, flame- retardant to provide adequate mechanical and thermal strength under normal and fault conditions.
- The bus bars shall be marked to indicate R, Y, B phase colour by painting in all the panels.
- The bolting area for bus joints on all the bus bars shall be silver plated.

9.0 11 kV ISOLATOR

9.1 General Specification:

11 kV, 400A, 3-Ph, 50Hz, 25kA/1sec, indoor type, panel mounted, manually operated Off-load type isolator with earth switch. The isolator should have following features:

- All Isolators offered shall be suitable for vertical upright mounting on steel structures. Each pole unit of the multiple Isolators shall be of identical construction and mechanically linked for gang operation.
- Each pole of the Isolator shall be provided with two sets of contacts to be operated in series and the moving contact blades shall rotate in vertical plane.

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- The design shall be such that the operating mechanism with the linkages shall be suitable for mounting on any of the outer pole ends without much difficulty and with minimum shifting of parts.
- The 11 KV Isolators offered by the Bidder shall be designed for Normal rating current for 400amp. It should be suitable for continuous service at the system voltages specified herein.
- The Isolators shall be suitable to carry the rated current continuously and full short circuit current of 25 KA for 11 KV respectively for 1 second at site condition without any appreciable rise in temperature. These shall also be suitable for operation at 110% rated (normal) voltage. The isolators shall be so constructed that they don't open under the influence of short circuit conditions.
- The Isolators and earthing switches are required to be used on electrically exposed installation and this should be taken into account while fixing the clearance between phases and between phase and earth.

9.2 TECHNICAL FEATURES

Sr No.	Description	Requirement
1	Type of Isolator	11kV, Indoor type, offload, Vertical mounted
2	Applicable standard	IS : 9921 / IEC-129/IEC-62271-102.
3	Rated voltage nominal /Maximum (kV)	11 kV/12kV
4	Rated Frequency	50 HZ \pm 3%
5	System earthing	effectively earthed
6	Temperature rise	As per relevant IS/IEC publication
7	Insulation level impulse withstand voltage :	
	a) Across Isolating distance(kV peak)	75
	b) To earthed & between poles(kV Peak)	75
8	1 minute power frequency withstand voltage	
	a) Across Isolating distance(kV Peak)	28
	b) To earthed & between poles(kV Peak)	28

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9	Rated current	400A
10	Short time current for 1 sec.	25KA
11	Operating mechanism	Manual

REMARKS:

The operating mechanism for earth switch 11 KV shall be operated manually.

9.3 STANDARDS

Disconnecting switches covered by this specification shall conform to latest edition IEC-129/IEC 62271-102 I.S.1813 and IS: 9921, IS-325, and unless specifically stated otherwise in this specification.

9.4 TESTS ON ISOLATORS:

Isolators offered, shall be fully routine tested as per the relevant standards.

10.0 AUTOMATIC CONTROL UNIT (ACU)

10.1 Switching Arrangement

The Automatic control unit shall be provided in the APFC panel to continuously monitor total KVAR requirement on secondary side of the transformer and shall automatically switch ON or switch OFF the capacitor banks through the operation of 12 KV Capacitor Switch. Overriding provision shall be made for electrical switching ON or OFF of the capacitor switch by the operator from the ACU control box. The Power factor controller will automatically switch equal or unequal capacitor bank stages in or out to regulate the System power factor to a preset (unity) value. The actual switching operation will be decided based on observation of load pattern and preset value of power factor after installation and commissioning

10.2 Time Delay:

An interposing factory set on-delay shall be provided to prevent the energization of a capacitor bank in not less than 10 minutes. The manufacturer of the bank shall confirm that when going from the "Manual" position to the "Auto" position on any stage, that the corresponding stage will not be energized in less than 10 minutes. The switching OFF operation of relevant steps will be instantaneous.

10.3 Controls

The Automatic control unit shall instantly switch OFF the incomer VCB of capacitor bank in the following contingencies occurring in any of the phases.

- a) Voltage increased by 10% above the rated voltage of 11 KV.
- b) Power transformer current impedance (due to single phasing and for any other reasons) between any of the two phases exceeding 20 % of the lowest.
- c) Current increases in any capacitor unit by 30% above the rated current (only the relevant capacitor switch will open). Current between any of the two phases of the capacitor bank differs more than 15% of the lowest current of the 3 phases (only the relevant capacitor switch will open).

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10.4 Monitoring Facility:

A digital ammeter with inbuilt selector switch to indicate the capacitor current in each step of the capacitor bank shall be provided on the panel. Indicating lamps will also be provided to indicate ON & OFF status of each step of capacitor banks.

In addition, the controller shall consist of the following features:

- a. Digital setting of individual parameters including target power factor, switching time, number of steps, etc.
- b. Digital indication of preset power-factor, preset parameters, and specified installation data.
- c. Controller should be communicable on Modbus RS-485 protocol.
- d. Automatic elimination of defective capacitor steps and their indication on the LCD display as also by LED indicators on the front fascia of the Controller.

A counter that counts the number of times each stage has been energized shall be provided.

10.5 METERING AND PROTECTION

i) CURRENT TRANSFORMERS (CT)

All CT shall be bar/ring primary type of 12 kV class, wound secondary construction, All CT should have two core, metering core should have minimum burden of 10VA and accuracy class 1 and protection core should have minimum burden of 10VA and accuracy class 5P10. Secondary windings of CT shall be wired to suitable terminal boards and grounded at one point using removable links. CT shall be identified by anodized aluminium label giving type, ratio, class, serial number, over-current factor and time rating.

ii) METERING

The indicating meters in the panels shall be digital type having inbuilt selector switch. All the meters shall be flush mounting and square pattern. Meters shall be calibrated to the appropriate grade in and due allowance made in such calibration for the instrument transformer to be used in service.

10.6 Control Power:

The DC control voltage (220V DC) and auxiliary AC power for the operation of the control unit shall be made available by IPR.

10.7 Temperature Variation:

The control equipment and associate circuitry shall be suitable for operation at an ambient temperature in the range of +5° C to (+) 50° C.

10.8 Protection of ACU:

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Besides in-built protection against lines surges and transient over voltages, suitable fuses/MCBs shall be provided for protection against over current. The ACU shall remain fully functional during and after line surges and transient over voltages.

10.9 Control Unit Casing:

Except for the terminals, the ACU shall be enclosed in a suitable casing so as to avoid ingress of dust.

11.0 APFC RELAY SPECIFICATIONS

The APFC relay should be selected for Power factor correction should address both balanced and unbalanced loads and should be provided with following features. APFC relay is capable of compensation to each phase individually or compensation to three phases and should have distinct feature of individual phase measurements and energy counting.

It should have complete three phase measurements

- | | |
|---|----------------------------|
| – Active power (KW) | - 3ph/1ph |
| – Apparent power (KVA) | -3ph/1ph |
| – Reactive power (KVAR) | -3ph/1ph |
| – Reactive power (KVAR) to reach the target cos phi | -3ph/1ph |
| – Cos phi | -3ph/1ph |
| – Total Harmonic Distortion on Voltage/Current | -THD V/I (%) |
| – Voltage/Current Harmonics | -H2 up to H49 (%-spectrum) |

Communication

With Modbus connection, suitable to the read the data from APFC relay in SCADA.

Measuring system

Micro-processor based system for balanced three-phase/single-phase networks and unbalanced network. APFC relay should work with both 5A and 1A CT's.

Power factor setting : From 0.7 inductive to 0.7 capacitive.

Starting current setting (C/k) : 0.01 to 5A.

11.0 HT HRC FUSES:

Suitable Indoor type 11 KV HRC fuses along with the mounting insulators etc. to be provided for proper protection of the entire installation. The rupturing capacity of the fuses shall be 40 KA or above.

12.0 CONTROL CABLE

The control cable shall conform to IS: 1554 (Part-I) 1976. The bidder shall furnish cable schedule for integrating with 11kV bus to the APFC panel during drawing approval.

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13.0 RATING PLATE

Each unit shall be fitted with a rating plate giving clearly the particulars specified of marking as per standards:

14.0 CLEARANCES

All clearances of live parts between phases and phase to earth shall be adequate.

15.0 ACCEPTANCE TESTS OF COMPLETE APFC UNIT:

The successful bidder has to submit quality assurance plan (QAP) which includes Factory acceptance test (FAT) plan and Site acceptance test (SAT) plan, for the purchaser's approval. FAT and SAT should be as per relevant IS/IEC Standard and would be finalized with mutual understanding of purchaser and supplier.

15.1 ACCEPTANCE TESTS (FAT & SAT):

- i. All factory acceptance tests on the complete unit, conforming to relevant Indian standards/IEC, shall be carried out by the supplier at his expense, in the presence of Purchaser's representative.
- ii. The supplier shall give sufficient advance intimation (minimum two weeks advance intimation), to enable purchaser to depute his representative for witnessing the FAT.
- iii. The method shall be subject to mutual agreement between the supplier and purchase where it is not specified in the relevant standards.
- iv. All site acceptance tests conforming to relevant Indian standards/IEC shall be carried out as mutually agreed and as per prevailing site conditions.

15.2 Factory ACCEPTANCE TESTS:

The following test has to be performed at site by the vendor.

- Capacitance measurement
- Measurement of the tangent of the loss angle ($\tan \delta$) of the capacitor
- Voltage test between terminals
- AC voltage test between terminals and container
- Test of internal discharge device
- Sealing test
- Discharge test on internal fuses

15.3 SITE ACCEPTANCE TESTS:

The following test has to be performed at site by the vendor.

- Physical inspection to see if any leakage or damage to capacitor.
- Meggar testing of the unit.

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- Capacitance measurement.

No material shall be dispatched without dispatch clearance from the purchaser.

16.0 WARRANTY:

The Bidder shall provide warranty for the performance of entire equipment and its components for 12 months from the date of commissioning or 18 months from the date of dispatch, whichever is earlier, as agreed upon and as reproduced in the purchase order data sheets within the tolerance specified or as permitted by relevant standards for the equipment in his scope of supply.

17.0 PACKING AND FORWARDING.

The equipment shall be packed in crates suitable for vertical / horizontal transport, as the case may be and suitable to withstand handling during transport and Indoor storage during transit. The supplier shall be responsible for any damage to the equipment during transit, due to improper and inadequate packing. The easily damageable material shall be carefully packed and marked with the appropriate caution symbols. Wherever necessary, proper arrangement for lifting, such as lifting hooks etc. shall be provided. Any material found short inside the packing cases shall be supplied by supplier without any extra cost. Each consignment shall be accompanied by a detailed packing list containing the following information:

- (a) Name of the consignee.
- (b) Details of consignment.
- (c) Destination.
- (d) Total weight of consignment.
- (e) Handling and unpacking instructions.
- (f) Bill of material indicating contents of each package.

The supplier shall ensure that the bill of material is approved by the purchaser before despatch.

18.0 DRAWINGS & DOCUMENTATION

18.1 The following drawings illustrating the technical details of APFC panel shall be submitted by each bidder.

- a) General outlines dimensional drawings of all the equipment with all technical details giving the net weights, ratings & capacity of the equipment and quantity.
- b) Detailed sectional views, showing the general constructional and other relevant features of various equipment.
- c) Schematic connection diagrams for complete capacitor banks with associated switchgear equipment.
- d) All above drawings in soft copies.

18.2 In the event of an order, the successful bidder shall furnish the following drawings,

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- a) General dimensional outline drawings showing front and side elevations and plan of APFC Panel.
- b) Any other relevant drawing required by purchaser.

18.3 Drawings, diagrams, instructions and reports shall be identified by descriptive titles indicating their applications to the equipment offered. All dimensions shall be in metric system.

18.4 All the drawings of individual equipment shall be marked with all Technical details, Guaranteed Technical Particulars, details of manufacturer etc.

18.5 On approval of the drawings, same shall be sent to the successful bidder for manufacturing the equipment.

19.0 INTERGATION WITH 11kV BUS

The APFC panel has to be integrated with existing 11kV bus. All the associated work viz. construction of required support structure for cable tray to reach APFC panel, HT cable laying, termination at both end etc. All the HT cables and control cables for integrating the APFC panel to 11kV bus shall be supplied by IPR.

20.0 INSTALLATION OPERATION AND MAINTENANCE

The supplier shall provide:

- 1) Necessary manual on installation, operation and maintenance as also the schedule for the routine testing or check-ups of all the equipment covered by the installation.
- 2) The supplier shall provide free of service of their engineers for erection, testing & commissioning of APFC panel along with its accessories at IPR.
- 3) The supplier shall provide 3 sets of detailed instruction manuals and drawings covering all aspects of installation and maintenance of the APFC panel and the associated equipment.

21.0 SCHEDULE OF DELIVERY

The following schedule has to be followed.

Sr.No.	Description	IPR Scope	Vendor's Scope	Time Schedule
1.	Issue of PO	✓		T ₀ (in months)
2.	Submission of GA drawing, design criteria/calculations etc and QAP		✓	T ₁ = T ₀ + 2 months
3.	Approval of GA drawing, design criteria/calculations etc and QAP	✓		T ₂ = T ₁ + 0.5 month
3.	Manufacturing of APFC		✓	T ₃ = T ₂ + 3 months

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4.	Factory Acceptance Test	✓	✓	$T_4 = T_3 + 0.5$ month
5.	Dispatch Clearance	✓		$T_5 = T_4 + 1$ month
6.	Delivery of APFC at site		✓	$T_6 = T_5 + 1$ month
6.	Erection, Installation, Integration with existing 11kV Bus, Site Testing and commissioning of the APFC System.		✓	$T_7 = T_6 + 2$ month

22.0 SUBMISSION

The following submissions shall become part of this Specification.

Sr No	Description of Item	With Offer	Order execution	
			For Approval	Final Copies
1.	Specification sheets	1 sets	1 sets	1 sets
2.	Technical Particulars/Data sheets	1 sets	1 sets	1 sets
	General Arrangement			
3.	Drawings, Weights, Dimensions	1 sets	1 sets	1 sets
4.	Schematic & Wiring Diagram, QAP	Not required	1 sets	1 sets
5.	Wiring Termination Details	Not required	1 sets	1 sets
6.	Installation, Operation & Maintenance Manual (Incl. bought out items)	Not required	Not required	1 sets
7.	Guarantee Certificate	Not required	Not required	1 sets
8.	Inspection & Test Certificates	Not required	Not required	1 sets
9.	Test Certificates for bought out items	Not required	Not required	1 sets
10.	Quality assurance plan	Not required	1 sets	Not required
11.	Soft copy of documentation & drawings	Not required	Not required	1 disc

Notwithstanding, as to what is specifically stated under the SCOPE OF WORK, it shall be the responsibility of the vendor to attend all the required work for 11kV, 1600KVAR, Automated Power Factor Correction (APFC) System and its integration with 11kV bus of 132 kV/11kV substation

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Abbreviations

SCC	Short Circuit Capacity
UGVCL	Uttar Gujarat Vij Company Ltd.
EHV	Extra high Voltage
CT	Current Transformer
SAT	Site Acceptance Test
O&M	Operation and Maintenance
OEM	Original equipment manufacturer
HV	High Voltage
LV	Low Voltage
RVT	Residual Voltage Transformer
CRCA	cold rolled cold annealed
ISMC	Indian Standard Medium Channel
FAT	Factory Acceptance Test
SAT	Site Acceptance Test
QAP	Quality Assurance Plan

TECHNICAL PARTICULARS FOR 11kV, 1600KVA_r APFC PANEL

Sr. No	Description	Requirement By IPR	As per Bidder
1.0	APFC Panel		
1.1	11 kV,1600KVA _r APFC Panel	01 Nos	.
1.2	Reference Standard	As per Specification	
1.3	Panel Type	Floor mounted, Indoor Type	
1.4	Installation	Indoor	
2.0	Panel cubicle Features		
2.1	Type of enclosure	Metal enclosed(CRCA)	
2.2	Thickness of sheet steel for various components		
2.2.1	Front door	2.0mm	
2.2.2	Structure members	2.0mm	
2.2.3	Cover	1.6mm	
2.2.4	Gland Plate	3.0mm	
2.2.5	Partition cover	1.6mm	
2.2.6	Degree of protection	Minimum IP-42	
2.3	Panel Accessories		
2.3.1	Panel Auxiliary	Required	

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	power/Heater/Illumination		
2.3.2	Control/protection for auxiliary	Required	
2.3.3	Provision of panel door switch	Required for lighting	
3.0	Vermin proofing for panels	Required	
4.0	Material of gasket	High density Rubber/Neoprene	
5.0	Type of door locking	Required	
6.0	Painting		
6.1	Method of painting	7 Tank process/ Dry powder epoxy coating	
6.2	Panel outside and inside paint shade	RAL 7032	
3.0	Bus Bar		
3.1	Material and grade	Electrical grade Aluminium. E91/E-WP	
3.3	Reference standard	IS:5082	
3.4	Main Bus bar size and nos. in each phase	1x 50x10mm	
3.5	Bus bar current rating	400 Amps, 3 phase, PVC insulated	
3.6	Clearance between bus bars	AS per applicable standard	
3.7	Phase identification mark	Required	
3.8	Insulation sleeves over bus bars	Heat shrink PVC sleeves	
3.9	Voltage grade of insulation sleeve	11kV grade	
3.10	Bus support insulators	AS per applicable standard	
3.10.1	Make	Suitable for voltage class	
3.10.2	Material of construction	Non-hygroscopic, epoxy resin cast	
3.10.3	Voltage Class	12kV	
3.10.4	Maximum temp for bus bar	< 90°C	
3.10.5	Tee-off bus junctions	PVC shrouds	
3.11	Earth bus		
3.11.1	Earth bus provided throughout the length of panel	Required	
3.11.2	Earth bus material and size	Copper, 30x10mm	
3.11.3	Earth bus short time current rating	25kA for 1 sec.	
3.11.4	Both ends brought out of panel for connecting with earth grid	Required with all necessary hardware	
4.0	Control Wiring		
4.1	Grade and type of wire	1.1kV Gr, PVC insulation multi-strand, flexible copper wires	
4.2	Color code of the wiring	AS per applicable standard	
5.0	Type of terminals		
5.1	For voltage, power and other ckt	Stackable type	
5.1.1	For CT circuits	Clip-on stud type with disconnecting link	
5.1.2	For PT circuits	Clip-on stud type	
6.0	Control supply		
6.1	Control for each panel	220VDC	

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7.0	Metering and protection accessories		
7.1	CT Parameter	Incomer:150/1/1Amp For 500KVAR: 50/1/1Amp For 300KVAR:30/1/1Amp	
7.1.1	Make	Any reputed make	
7.1.2	Type of CT	Resin cast bar primary/ring Type	
7.1.3	Insulation class	Class F	
8.0	PT Parameter	11kV/ $\sqrt{3}$ /110V/ $\sqrt{3}$,100VA,class-1	
8.1	Make / Type	Any reputed make	
9.0	APFC RELAY/ CONTROLLER DETAILS		
9.1	Make	Power Matrix / Beluk / ABB	
9.2	Number of stage	Six stage connected in 11kV system	
4.0	Vacuum Contactor		
4.1	Make	CGL/ABB/Siemens/Schneider	
4.2	Rated Current	400 Amps	
4.3	Operating Voltage	11kV	
4.4	Frequency	50Hz	
4.5	No of Poles	3 Poles	
5.0	HT Capacitor Bank		
5.1	Reference standard	IS : 13925	
5.2	Nominal system voltage	11kV	
5.3	Derated voltage of capacitor bank	----- kV	
5.4	Output of capacitor bank at 11 KV	1600 KVAR	
5.5	Capacitors Bank Step rating in KVAR @ 11kV	300KVAR	500KVAR
5.6	Derated Output (KVAR)	-----	-----
5.7	No. of steps	2	2
5.8	Make	Energie capacitors / universal cable /ABB/Shreem or equivalent	
5.9	Banking Details		
5.9.1	Types of Bank	Indoor in sheet steel cubical	
5.9.2	Connection	Internal Star	
6.0	Dry Type Series Reactor		
6.1	Reference Standard	IS: 5553	
6.2	Type of Reactor	Dry Type, Air cored (Indoor Panel mounted)	
6.3	Make	Quality Power, Shrihans,Herco Transformer or equivalent	
6.4	Rated Voltage & Frequency, (kV, Hz)	11kV , 50 Hz	
6.5	No. of Phase	Three Phase	
6.6	Per Phase Reactance , Ohms		
6.7	Rated Output, KVAR		
6.8	Rated Current, Amps		
6.9	Class of Insulation	Class – F or above	
6.10	Winding materials	Copper	

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6.11	Quantities (Nos.)	---- Nos.	
7.0	Isolator		
7.1	Applicable standard	IS : 9921 / IEC-129/IEC-62271-102.	
7.2	Type of Isolator	11kV, Indoor type, offload with earth switch, Vertical mounted	
7.3	Make	Pantagon switchgear, A.bond Strands or equivalent	
7.4	Rated current	400A	
7.5	Operating mechanism	Manual	